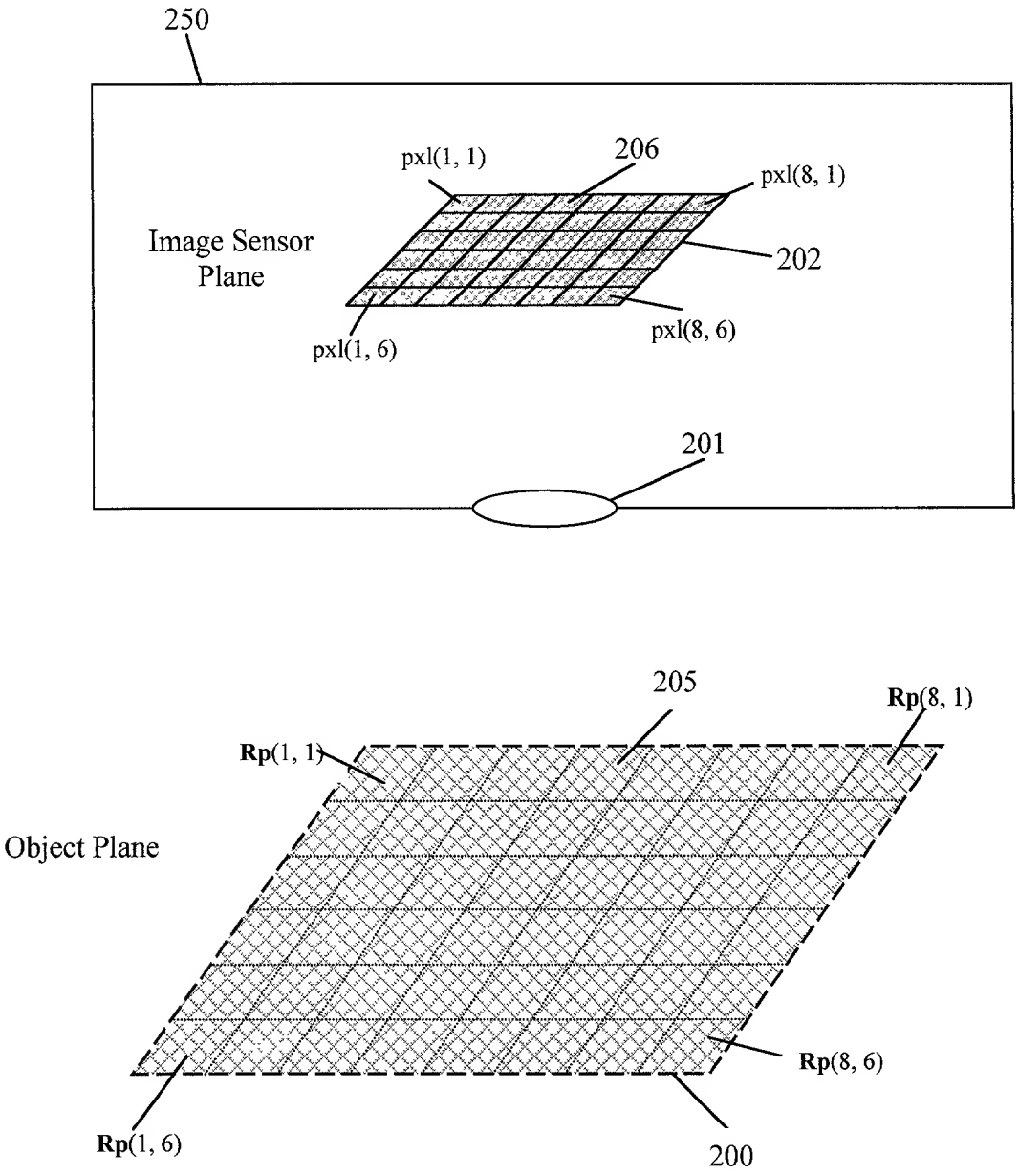

250
pxl(1, 1)
206
pxl(8, 1)
Image Sensor Plane
202
pxl(1, 6)
pxl(8, 6)
201
205
Rp(8, 1)
Rp(1, 1)
Object Plane
Rp(8, 6)
Rp(1, 6)
200

Figure 1

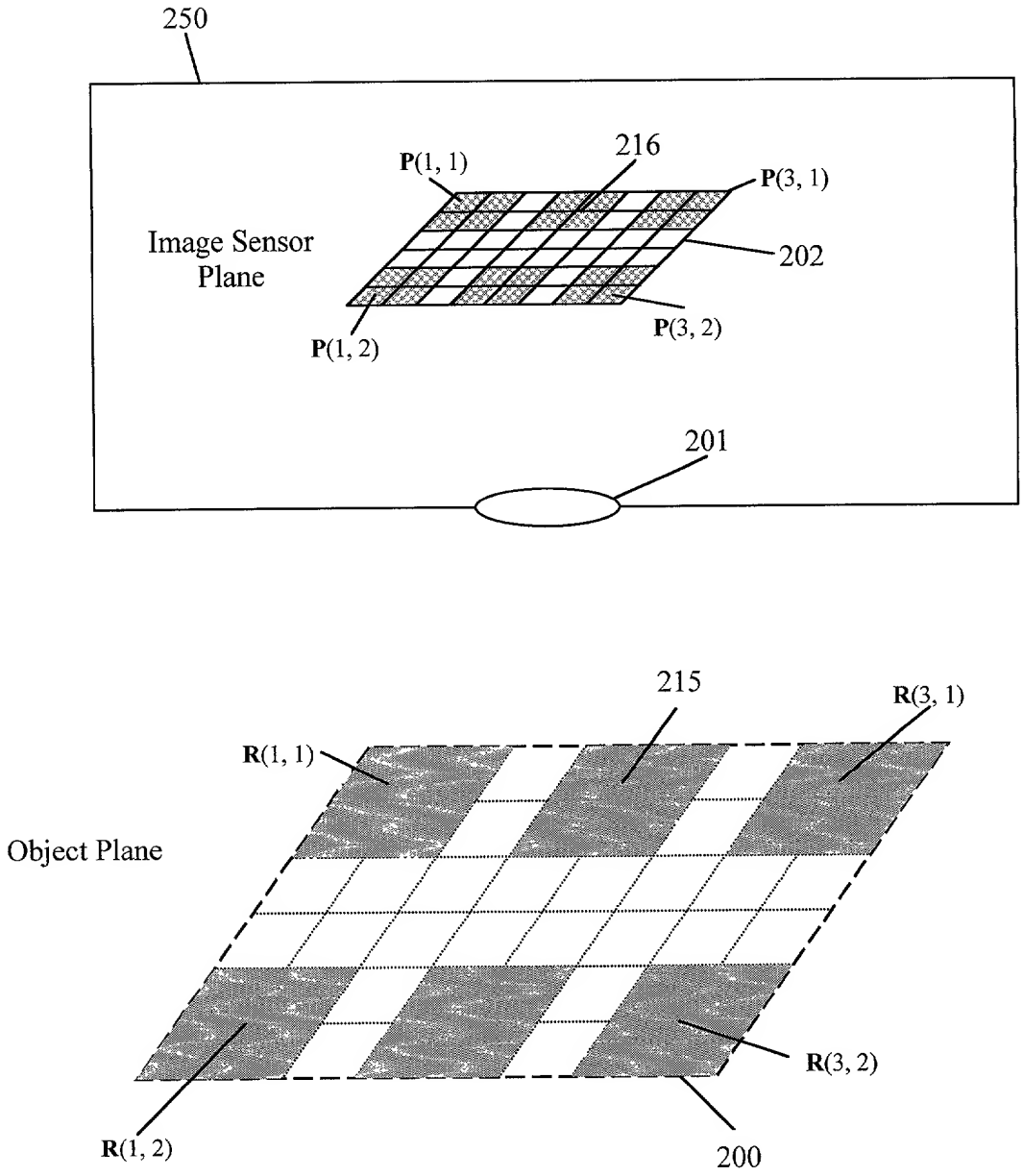

250
216
P(1, 1)
P(3, 1)
Image Sensor
Plane
202
P(3, 2)
P(1, 2)
201
215
R(3, 1)
R(1, 1)
Object Plane
R(3, 2)
R(1, 2)
200

Figure 2

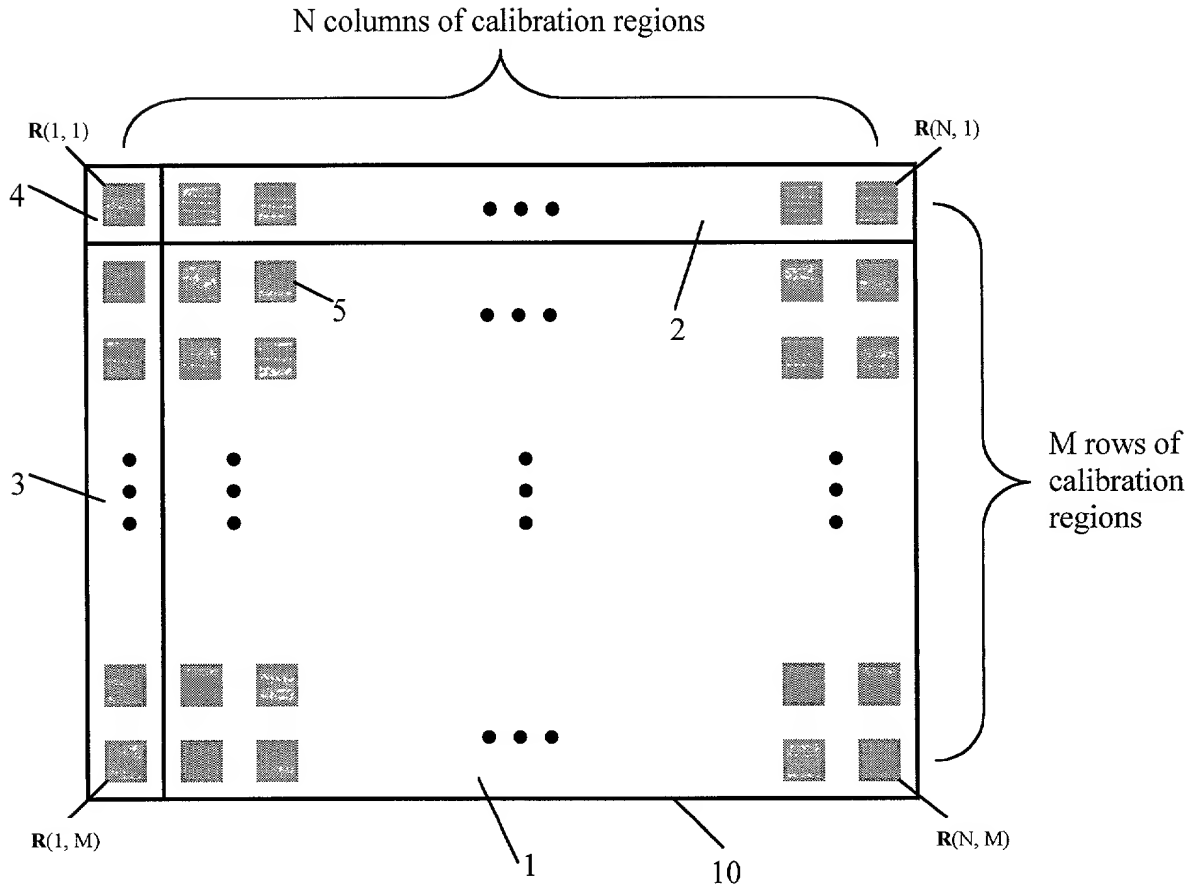
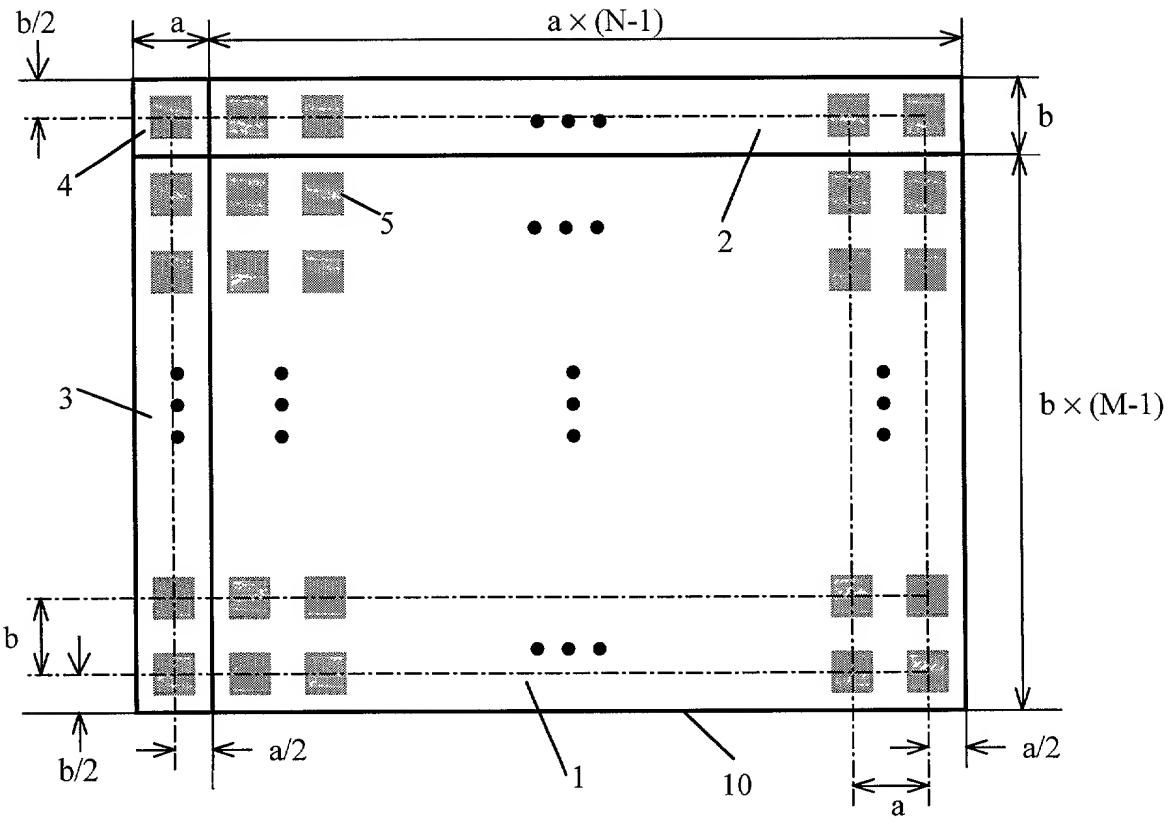

N columns of calibration regions
R(1, 1)
R(N, 1)
4
5
2
3
M rows of calibration regions
R(1, M)
R(N, M)
1
10

Figure 3



a: horizontal interval of calibration regions

b: vertical interval of calibration regions

Figure 4

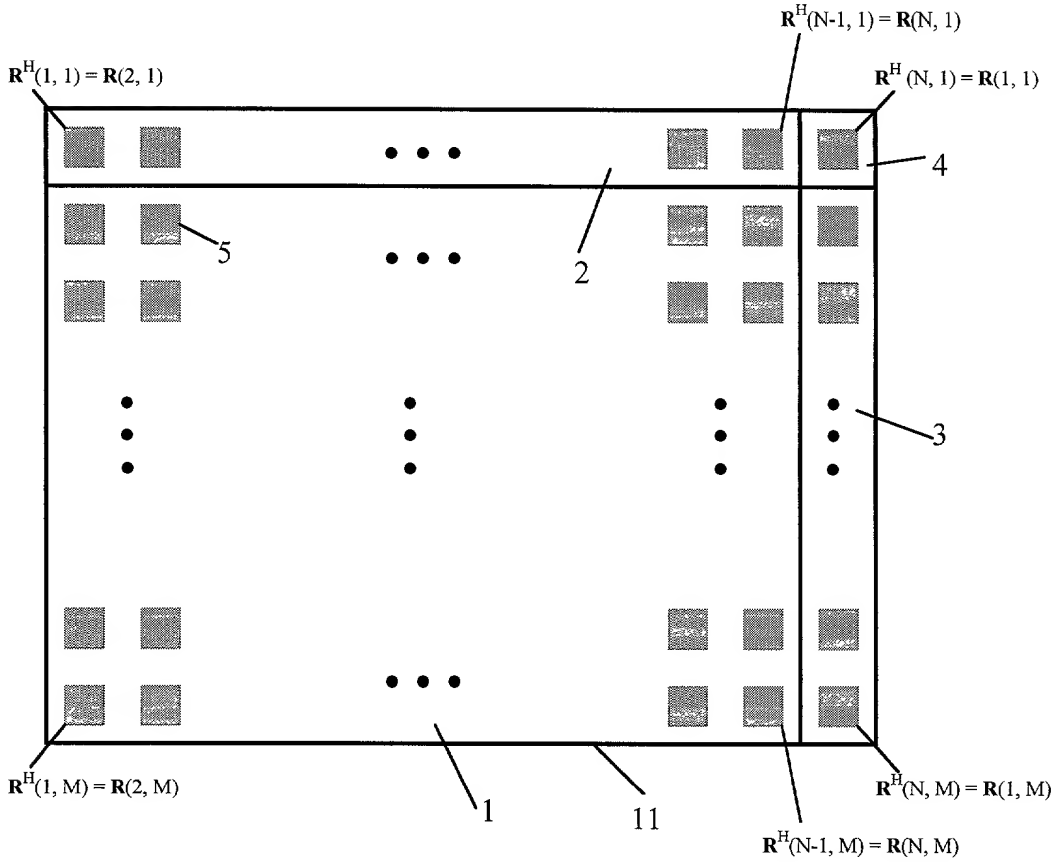

$\mathbf{R}^H(N\text{-}1, 1) = \mathbf{R}(N, 1)$
$\mathbf{R}^H(1, 1) = \mathbf{R}(2, 1)$
$\mathbf{R}^H(N, 1) = \mathbf{R}(1, 1)$
4
5
2
3
$\mathbf{R}^H(1, M) = \mathbf{R}(2, M)$
1
11
$\mathbf{R}^H(N, M) = \mathbf{R}(1, M)$
$\mathbf{R}^H(N\text{-}1, M) = \mathbf{R}(N, M)$

Figure 5

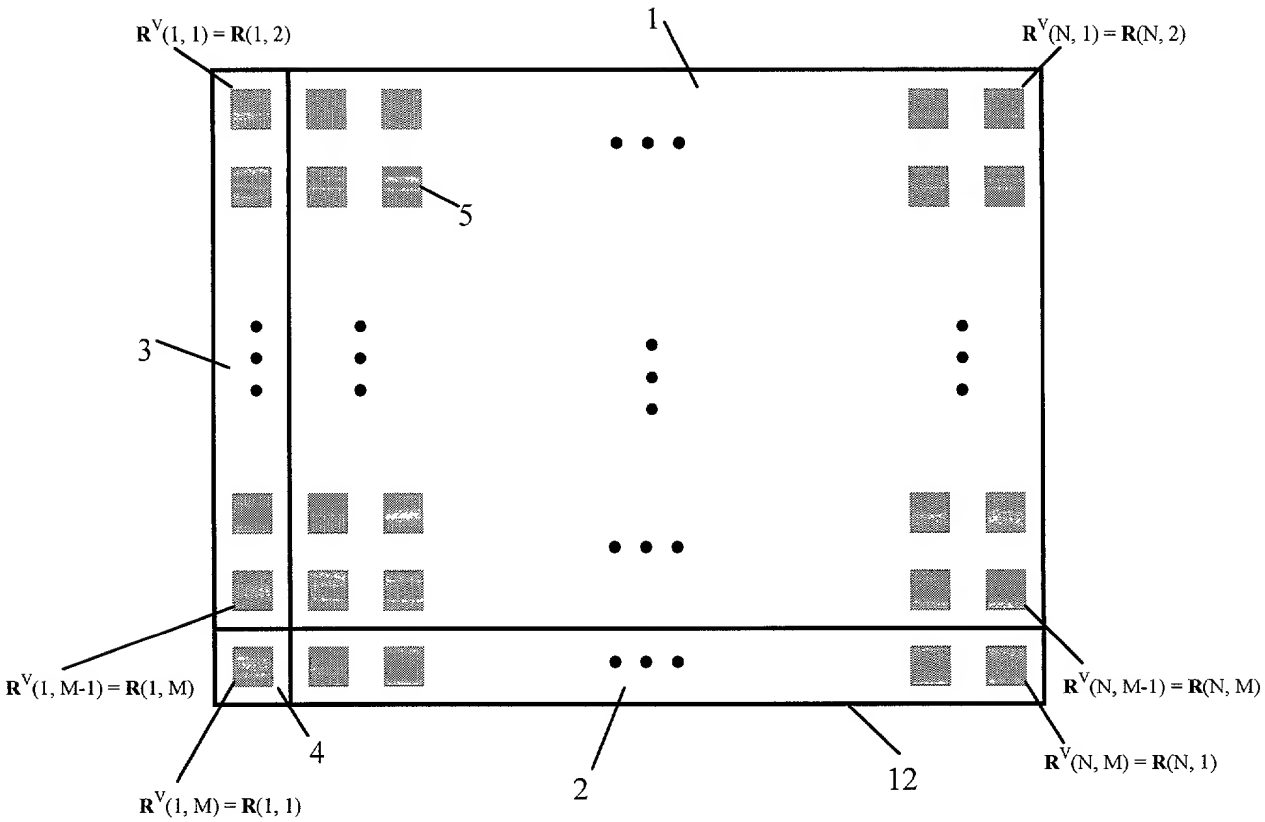

$\mathbf{R}^V(1, 1) = \mathbf{R}(1, 2)$
1
$\mathbf{R}^V(N, 1) = \mathbf{R}(N, 2)$
5
3
$\mathbf{R}^V(1, M-1) = \mathbf{R}(1, M)$
$\mathbf{R}^V(N, M-1) = \mathbf{R}(N, M)$
4
2
12
$\mathbf{R}^V(N, M) = \mathbf{R}(N, 1)$
$\mathbf{R}^V(1, M) = \mathbf{R}(1, 1)$

Figure 6

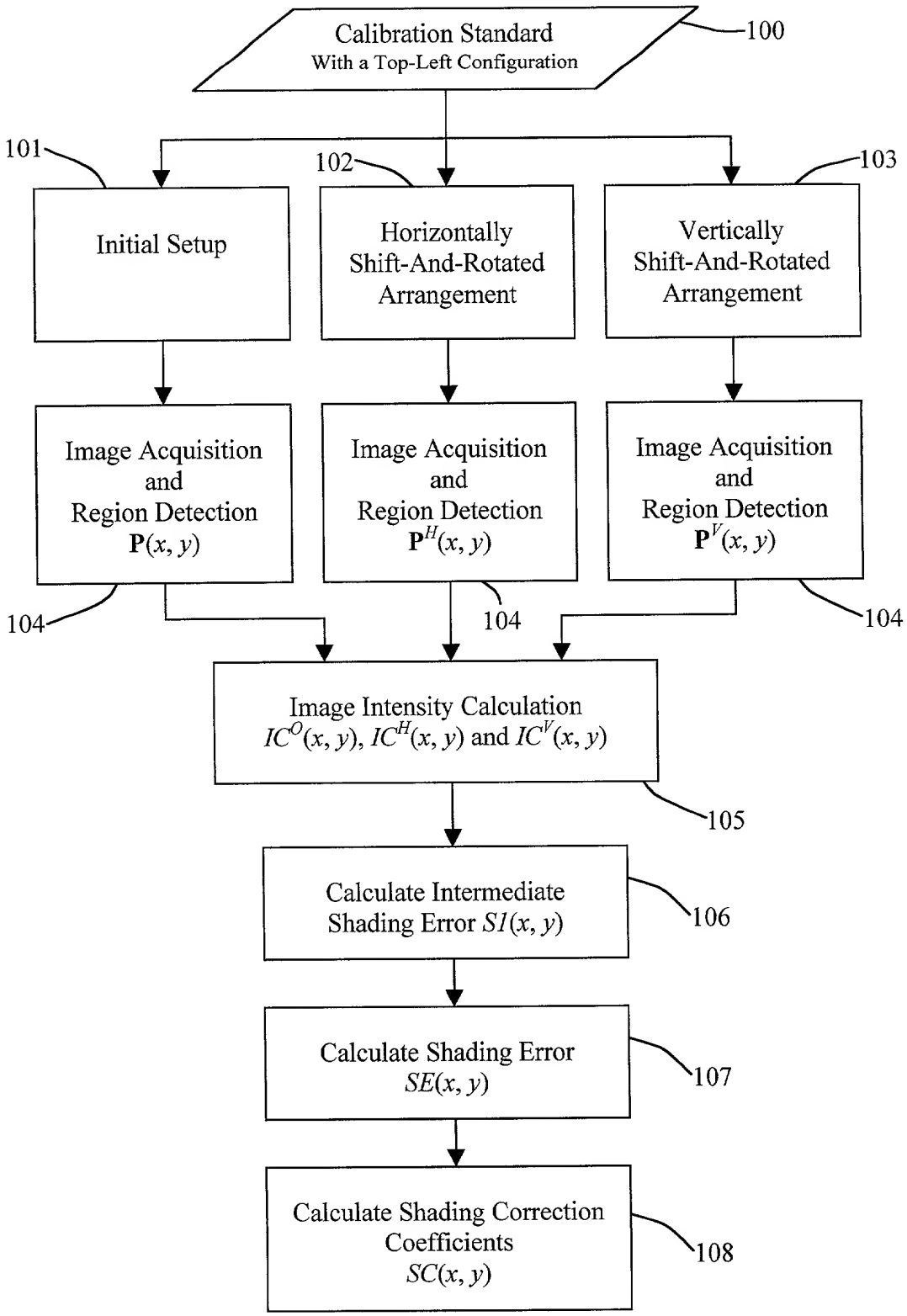

Calibration Standard
With a Top-Left Configuration
100
101
102
103
Initial Setup
Horizontally Shift-And-Rotated Arrangement
Vertically Shift-And-Rotated Arrangement
Image Acquisition and Region Detection
$\mathbf{P}(x, y)$
Image Acquisition and Region Detection
$\mathbf{P}^H(x, y)$
Image Acquisition and Region Detection
$\mathbf{P}^V(x, y)$
104
104
104
Image Intensity Calculation
$IC^O(x, y)$, $IC^H(x, y)$ and $IC^V(x, y)$
105
Calculate Intermediate Shading Error $SI(x, y)$
106
Calculate Shading Error
$SE(x, y)$
107
Calculate Shading Correction Coefficients
$SC(x, y)$
108

Figure 7

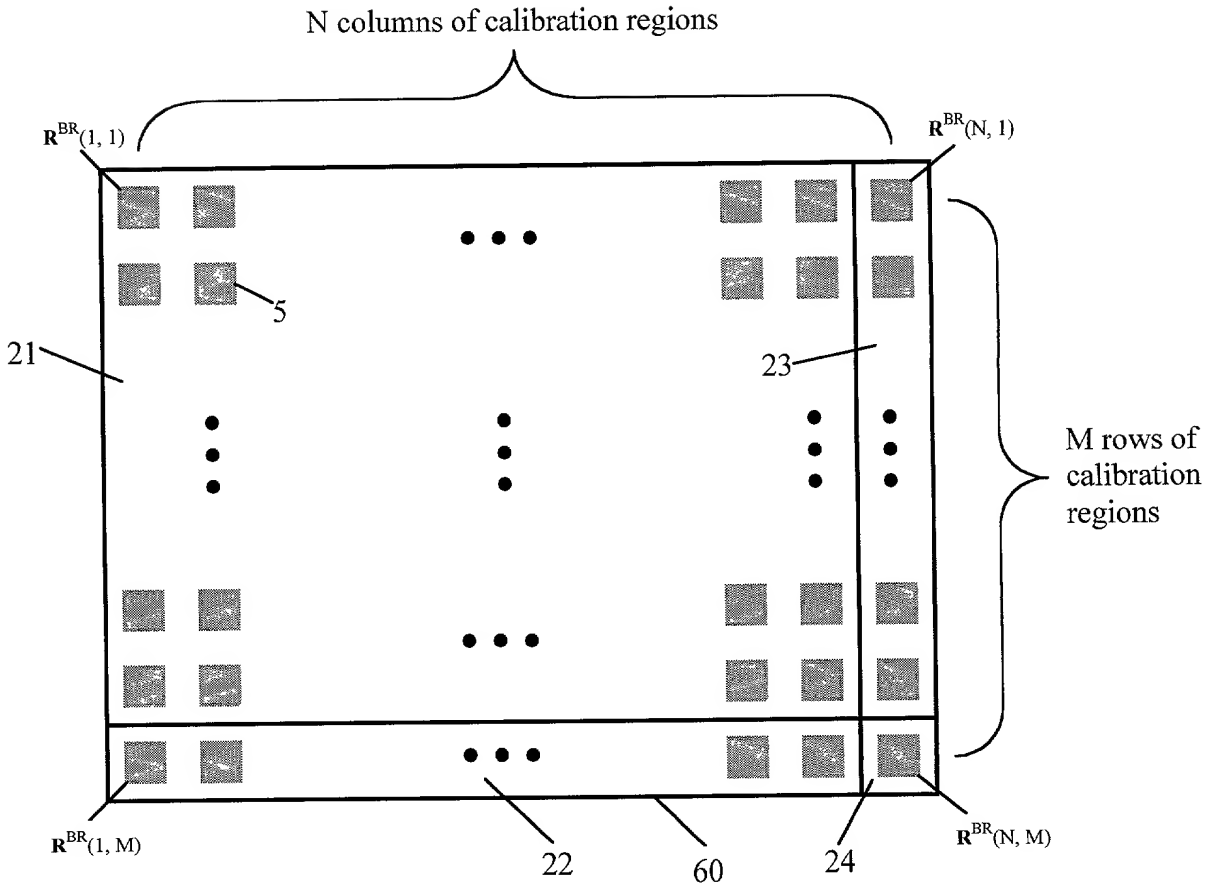

N columns of calibration regions
$R^{BR}(1, 1)$
$R^{BR}(N, 1)$
5
21
23
M rows of calibration regions
$R^{BR}(1, M)$
22
60
24
$R^{BR}(N, M)$

Figure 8

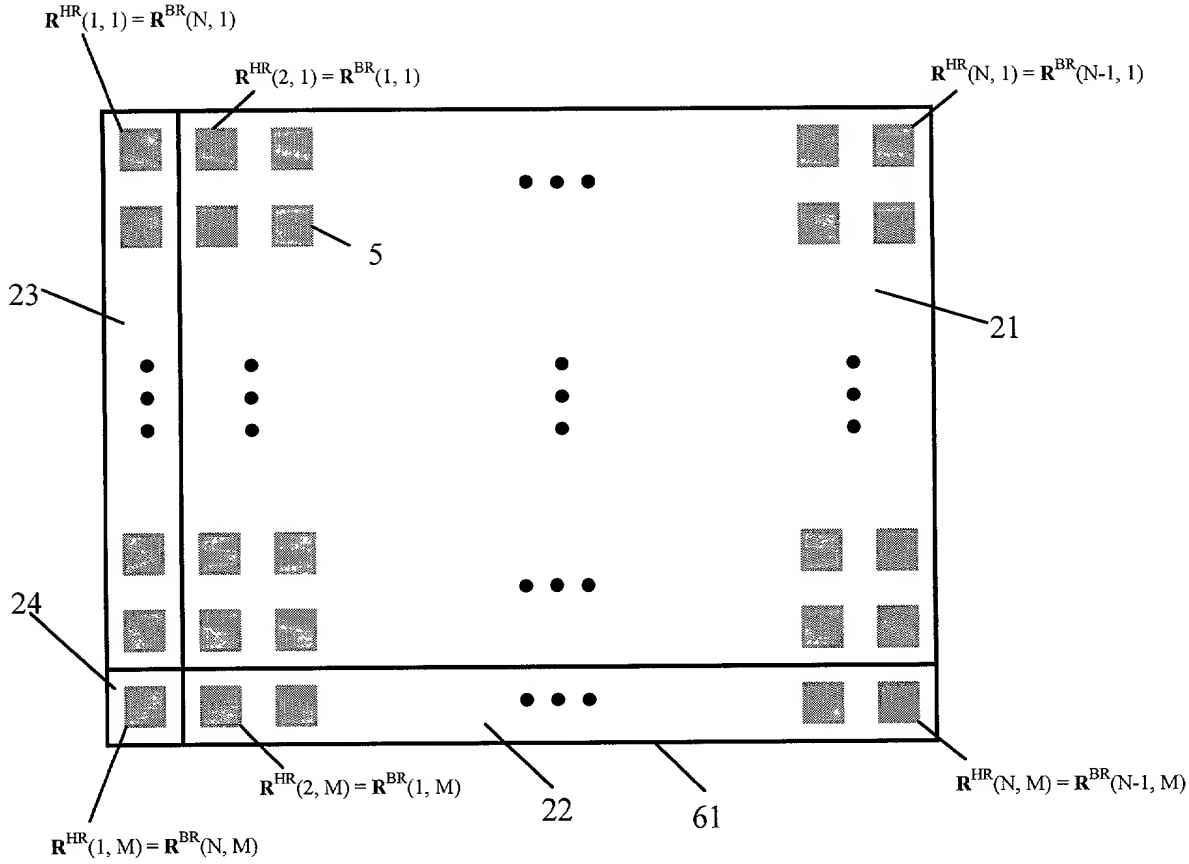

$\mathbf{R}^{HR}(1, 1) = \mathbf{R}^{BR}(N, 1)$
$\mathbf{R}^{HR}(2, 1) = \mathbf{R}^{BR}(1, 1)$
$\mathbf{R}^{HR}(N, 1) = \mathbf{R}^{BR}(N-1, 1)$
5
23
21
24
$\mathbf{R}^{HR}(2, M) = \mathbf{R}^{BR}(1, M)$
22
61
$\mathbf{R}^{HR}(N, M) = \mathbf{R}^{BR}(N-1, M)$
$\mathbf{R}^{HR}(1, M) = \mathbf{R}^{BR}(N, M)$

Figure 9

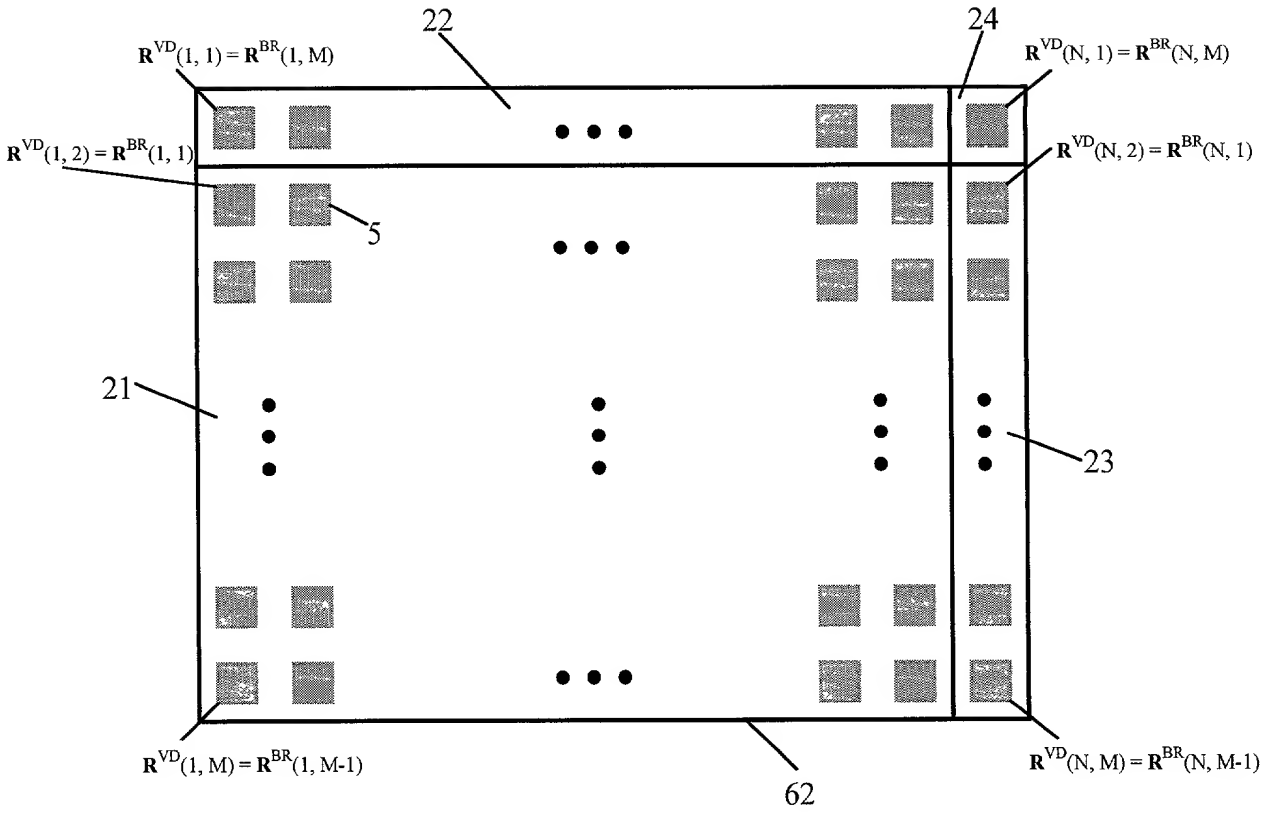

22
24
$\mathbf{R}^{VD}(1, 1) = \mathbf{R}^{BR}(1, M)$
$\mathbf{R}^{VD}(N, 1) = \mathbf{R}^{BR}(N, M)$
$\mathbf{R}^{VD}(1, 2) = \mathbf{R}^{BR}(1, 1)$
$\mathbf{R}^{VD}(N, 2) = \mathbf{R}^{BR}(N, 1)$
5
21
23
$\mathbf{R}^{VD}(1, M) = \mathbf{R}^{BR}(1, M-1)$
$\mathbf{R}^{VD}(N, M) = \mathbf{R}^{BR}(N, M-1)$
62

Figure 10

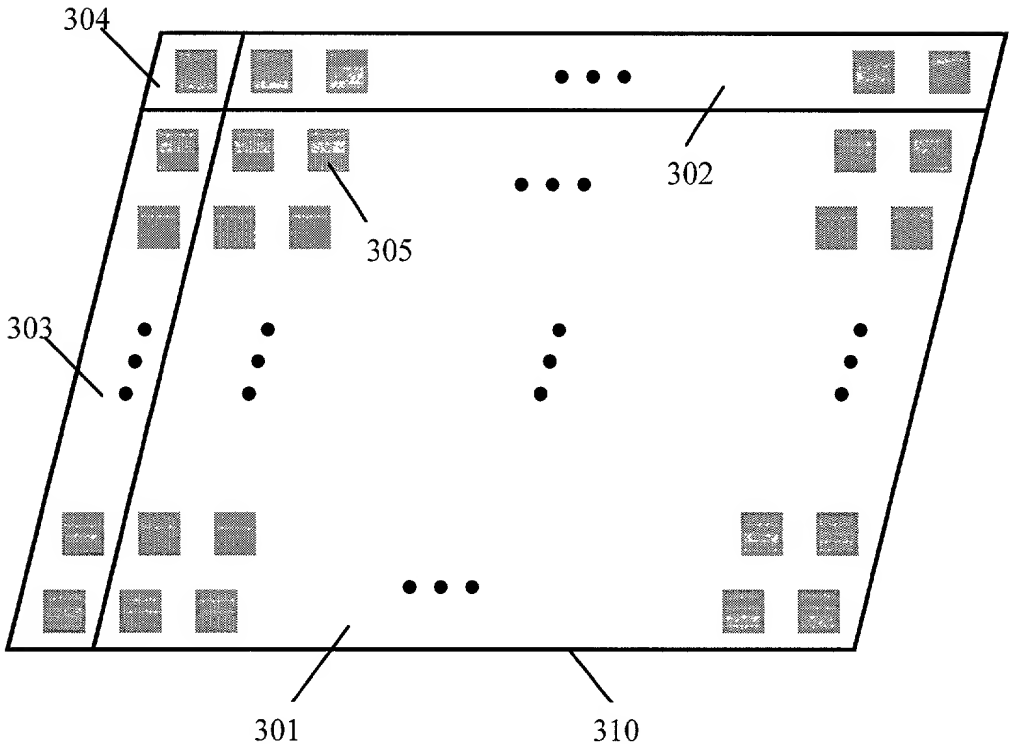


Figure 11

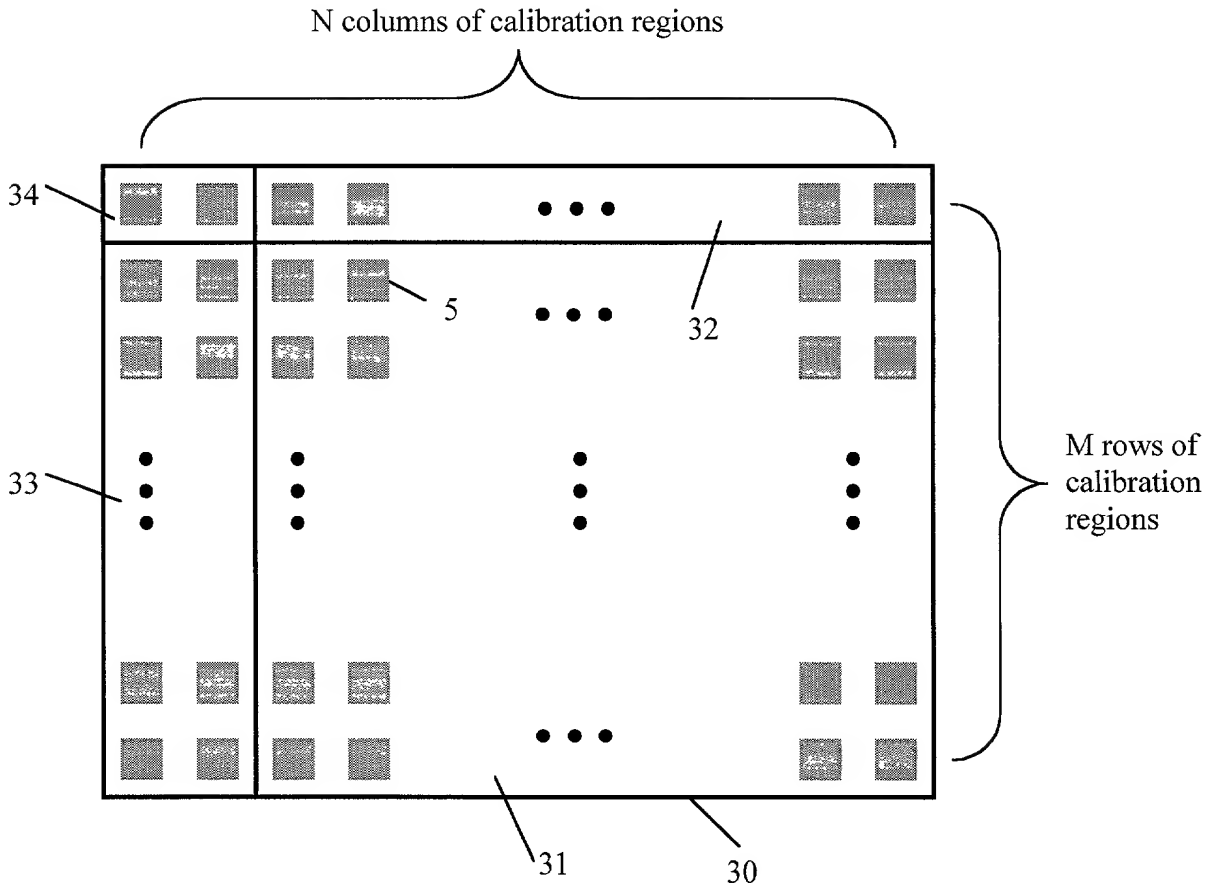

N columns of calibration regions
34
5
32
33
M rows of calibration regions
31
30

Figure 12

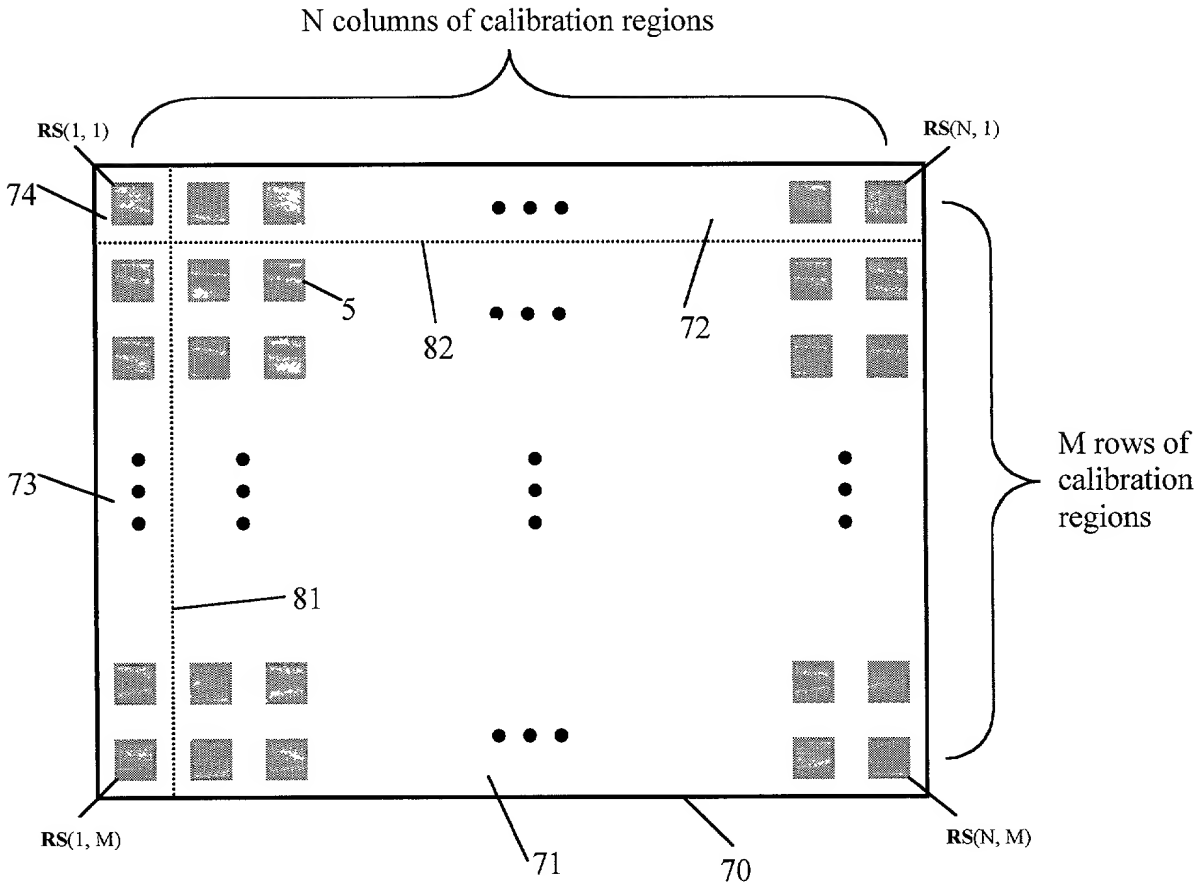

N columns of calibration regions
RS(1, 1)
RS(N, 1)
74
5
82
72
73
M rows of calibration regions
81
RS(1, M)
71
70
RS(N, M)

Figure 13

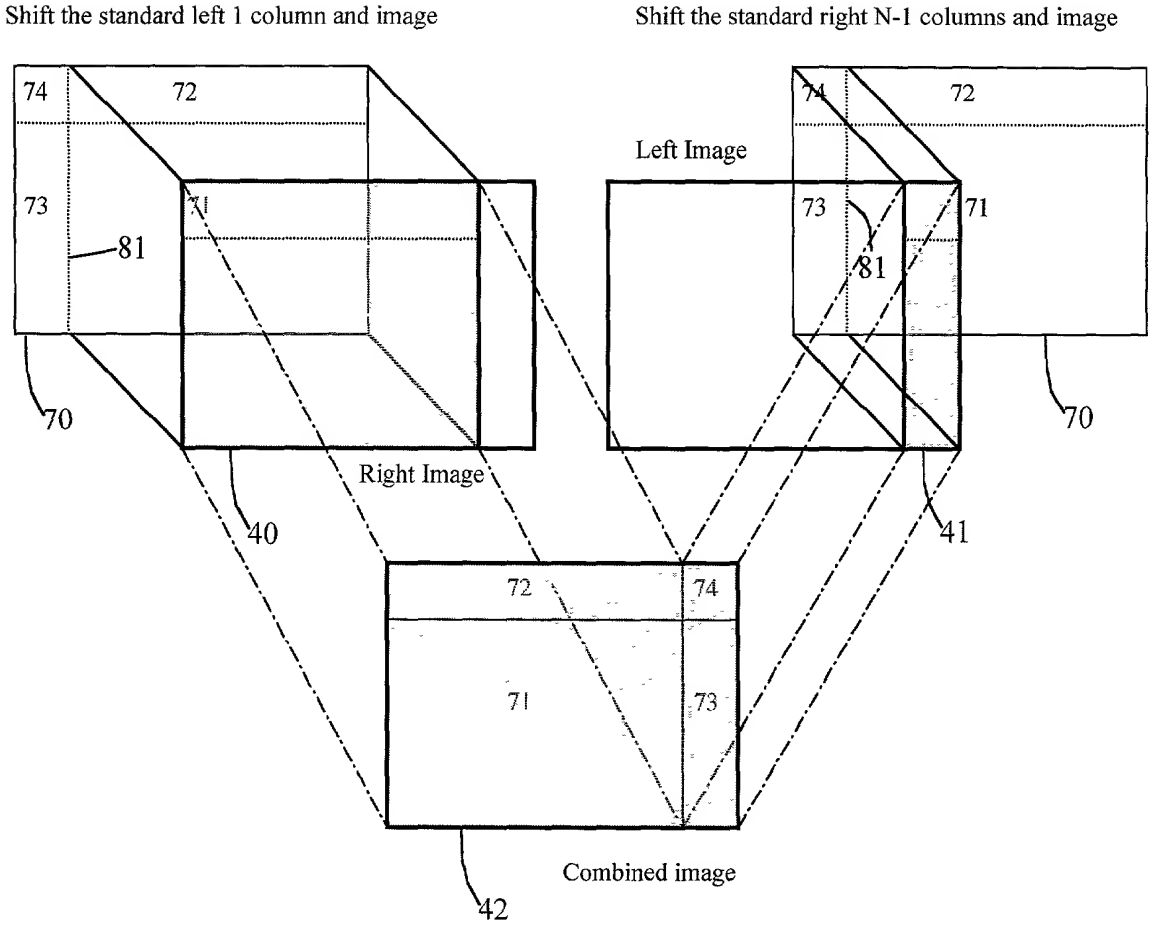

Shift the standard left 1 column and image
Shift the standard right N-1 columns and image
74
72
73
71
81
70
Left Image
Right Image
40
41
72
74
71
73
Combined image
42

Figure 14

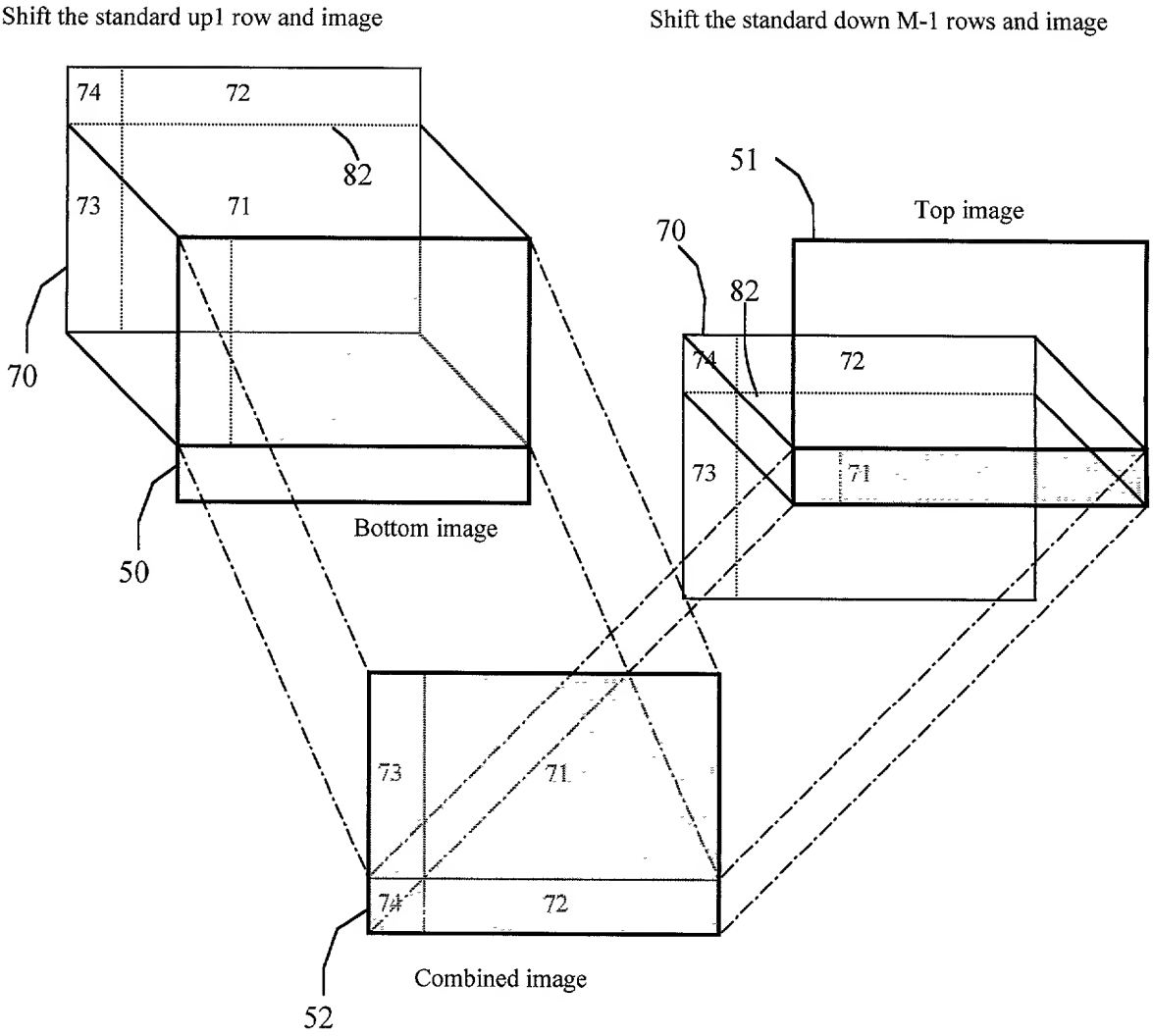

Shift the standard up1 row and image
Shift the standard down M-1 rows and image
74
72
82
73
71
70
Bottom image
50
51
Top image
70
82
74
72
73
71
73
71
74
72
Combined image
52

Figure 15

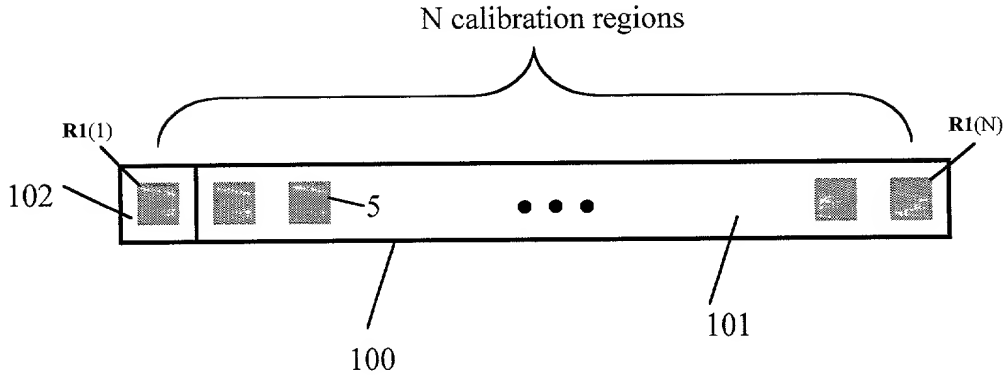


Figure 16

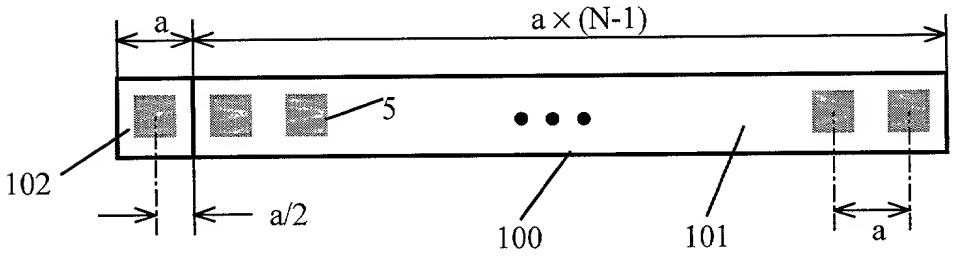


Figure 17

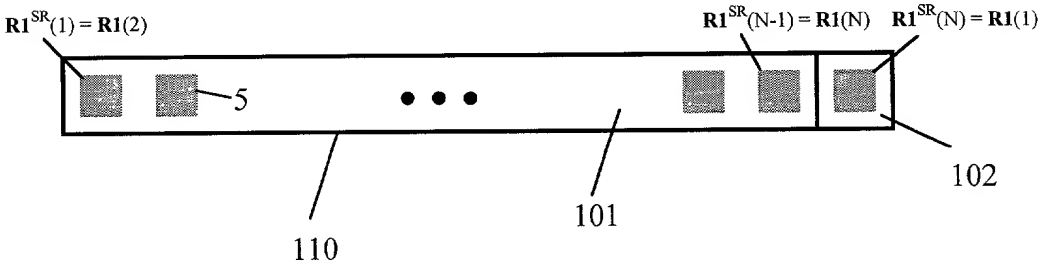


Figure 18

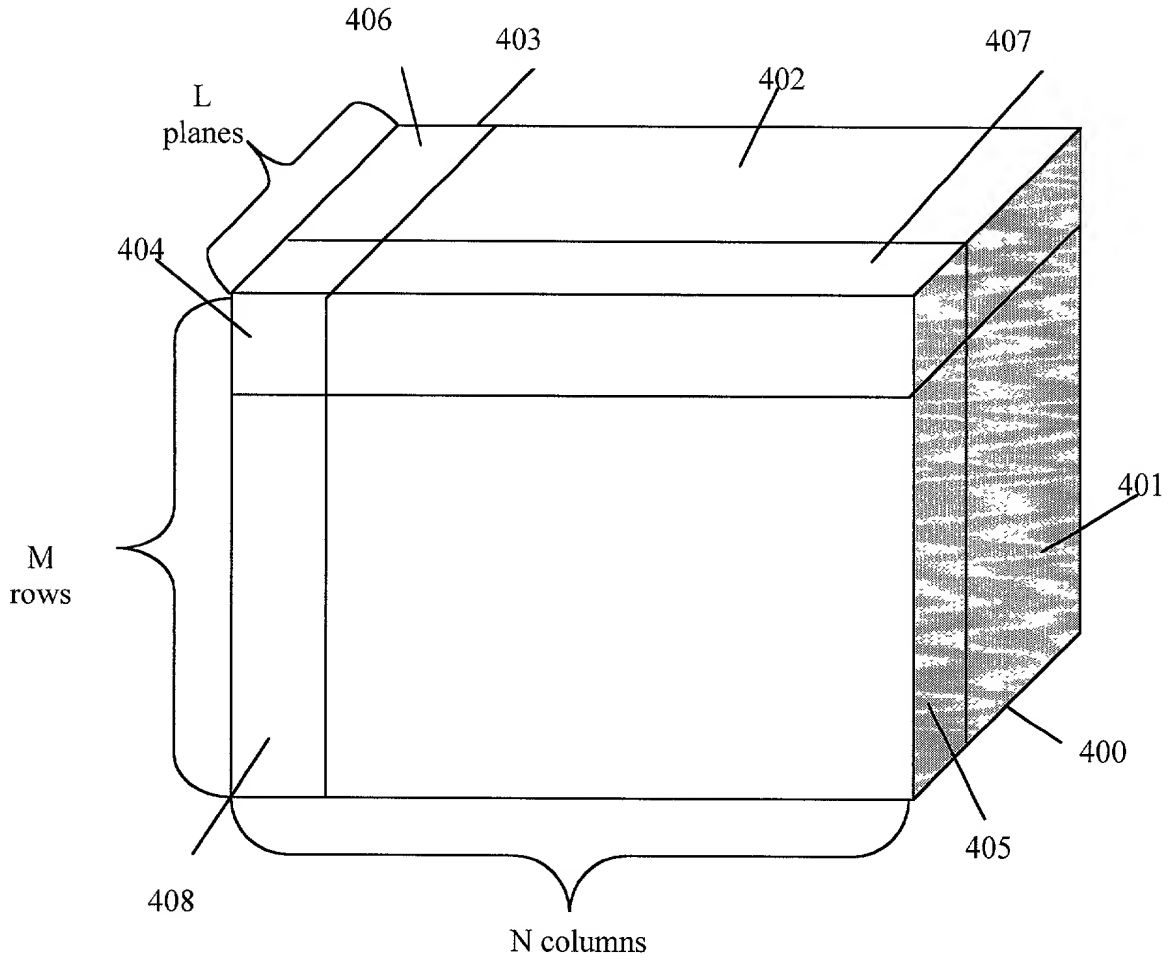


Figure 19